

## CLAIMS

1. An apparatus for generating a three-phase pulse-width-modulation signal for a three-phase voltage inverter employing a semiconductor switching element, the apparatus  
5 comprising:
  - a generating unit that generates the three-phase pulse-width-modulation signal based on a combination of three basic voltage vectors and a zero vector.
- 10 2. The apparatus according to claim 1, wherein the generating unit includes
  - a creating unit that creates two basic voltage vectors having a phase difference of 60 degrees and at least a zero vector by allocating occurrence time ratios  
15 for two basic voltage vectors having a phase difference of 60 degrees with a voltage command vector therebetween and a corresponding zero vector based on the voltage command vector; and
    - a distributing unit that distributes an  
20 occurrence time ratio of the voltage command vector to three basic voltage vectors having a phase difference of 120 degrees including one of the two basic voltage vectors having a phase difference of 60 degrees, using three  
25 vectors with equal lengths having a phase difference of 120 degrees and constituting a zero vector corresponding to the voltage command vector, to create three basic voltage vectors having a phase difference of 60 degrees and a zero vector based on the occurrence time ratio distributed.
- 30 3. The apparatus according to claim 1, wherein the generating unit includes
  - a creating unit that creates two basic voltage vectors having a phase difference of 60 degrees and at

least a zero vector by allocating occurrence time ratios for two basic voltage vectors having a phase difference of 60 degrees with a voltage command vector therebetween and a corresponding zero vector based on the voltage command

5 vector; and

a distributing unit that distributes an occurrence time ratio of the voltage command vector to three basic voltage vectors having a phase difference of 120 degrees including one of the two basic voltage vectors  
10 having a phase difference of 60 degrees, using three vectors with equal lengths having a phase difference of 120 degrees and constituting a zero vector corresponding to the voltage command vector, to create three basic voltage vectors having a phase difference of 60 degrees and a zero  
15 vector based on the occurrence time ratio distributed, with an occurrence time ratio of a basic voltage vector in a middle of the three basic voltage vectors having a phase difference of 60 degrees set to a predetermined value.

20 4. The apparatus according to claim 1, wherein the generating unit includes

a creating unit that creates two basic voltage vectors having a phase difference of 60 degrees and at least a zero vector by allocating occurrence time ratios  
25 for two basic voltage vectors having a phase difference of 60 degrees with a voltage command vector therebetween and a corresponding zero vector based on the voltage command vector; and

a distributing unit that distributes an occurrence time ratio of the voltage command vector to  
30 three basic voltage vectors having a phase difference of 120 degrees including one of the two basic voltage vectors having a phase difference of 60 degrees, using three

vectors with equal lengths having a phase difference of 120 degrees and constituting a zero vector corresponding to the voltage command vector, to create three basic voltage vectors having a phase difference of 60 degrees and a zero vector based on the occurrence time ratio distributed, and the three-phase PWM-signal generating apparatus further comprises a switching unit that switches, based on at least one of a load state, an operation frequency, and an angle range of an inverter rotation angle of a motor driven by the three-phase voltage inverter, generation of a three-phase PWM signal using two kinds of basic voltage vectors having a phase difference of 60 degrees and at least one kind of a zero vector produced by the producing unit and generation of a three-phase PWM signal using three kinds of basic voltage vectors having phase differences of 60 degrees and one kind of a zero vector produced by the distributing unit.

5. The apparatus according to claim 1, wherein the generating unit includes
- a creating unit that creates two basic voltage vectors having a phase difference of 60 degrees and at least a zero vector by allocating occurrence time ratios for two basic voltage vectors having a phase difference of 60 degrees with a voltage command vector therebetween and a corresponding zero vector based on the voltage command vector; and
  - a distributing unit that distributes an occurrence time ratio of the voltage command vector to three basic voltage vectors having a phase difference of 120 degrees including one of the two basic voltage vectors having a phase difference of 60 degrees, using three vectors with equal lengths having a phase difference of 120

degrees and constituting a zero vector corresponding to the voltage command vector, to create three basic voltage vectors having a phase difference of 60 degrees and a zero vector based on the occurrence time ratio distributed, with

5 an occurrence time ratio of a basic voltage vector in a middle of the three basic voltage vectors having a phase difference of 60 degrees set to a predetermined value, and the three-phase PWM-signal generating apparatus further comprises a switching unit that switches, based on

10 at least one of a load state, an operation frequency, and an angle range of an inverter rotation angle of a motor driven by the three-phase voltage inverter, generation of a three-phase PWM signal using two kinds of basic voltage vectors having a phase difference of 60 degrees and at

15 least one kind of a zero vector produced by the producing unit and generation of a three-phase PWM signal using three kinds of basic voltage vectors having phase differences of 60 degrees and one kind of a zero vector produced by the distributing unit.

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6. The apparatus according to claim 1, wherein the generating unit includes

a creating unit that creates two basic voltage vectors having a phase difference of 60 degrees and at

25 least a zero vector by allocating occurrence time ratios for two basic voltage vectors having a phase difference of 60 degrees with a voltage command vector therebetween and a corresponding zero vector based on the voltage command vector; and

30

a distributing unit that distributes an occurrence time ratio of the voltage command vector to three basic voltage vectors having a phase difference of 120 degrees including one of the two basic voltage vectors

having a phase difference of 60 degrees, using three vectors with equal lengths having a phase difference of 120 degrees and constituting a zero vector corresponding to the voltage command vector, to create three basic voltage  
5 vectors having a phase difference of 120 degrees and at least a zero vector based on the occurrence time ratio distributed.

7. The apparatus according to claim 1, wherein  
10 the generating unit includes
- a creating unit that creates two basic voltage vectors having a phase difference of 60 degrees and at least a zero vector by allocating occurrence time ratios for two basic voltage vectors having a phase difference of  
15 60 degrees with a voltage command vector therebetween and a corresponding zero vector based on the voltage command vector; and
  - a distributing unit that distributes an occurrence time ratio of the voltage command vector to  
20 three basic voltage vectors having a phase difference of 120 degrees including one of the two basic voltage vectors having a phase difference of 60 degrees, using three vectors with equal lengths having a phase difference of 120 degrees and constituting a zero vector corresponding to the  
25 voltage command vector, to create three basic voltage vectors having a phase difference of 120 degrees and at least a zero vector based on the occurrence time ratio distributed, and
- the three-phase PWM-signal generating apparatus  
30 further comprises a switching unit that switches, based on at least one of a load state, an operation frequency, and an angle range of an inverter rotation angle of a motor driven by the three-phase voltage inverter, generation of a

three-phase PWM signal using two kinds of basic voltage vectors having a phase difference of 60 degrees and at least one kind of a zero vector produced by the producing unit and generation of a three-phase PWM signal using three  
5 kinds of basic voltage vectors having phase differences of 120 degrees and one kind of a zero vector produced by the distributing unit.

8. The apparatus according to claim 1, wherein

10 the generating unit includes

a creating unit that creates two basic voltage vectors having a phase difference of 60 degrees and at least a zero vector by allocating occurrence time ratios for two basic voltage vectors having a phase difference of  
15 60 degrees with a voltage command vector therebetween and a corresponding zero vector based on the voltage command vector; and

a distributing unit that distributes an occurrence time ratio of the voltage command vector to  
20 three basic voltage vectors having a phase difference of 120 degrees including one of the two basic voltage vectors having a phase difference of 60 degrees, using three vectors with equal lengths having a phase difference of 120 degrees and constituting a zero vector corresponding to the  
25 voltage command vector, to create,

when an operation request range on a low speed side is not stringent, a first combination of three basic voltage vectors having a phase difference of 60 degrees and at least a zero vector based on the occurrence time ratio  
30 distributed, and

when the operation request range on a low speed side is stringent, a second combination of three basic voltage vectors having a phase difference of 120 degrees

and at least a zero vector based on the occurrence time ratio distributed.

9. The apparatus according to claim 7, wherein

5 the generating unit includes

a creating unit that creates two basic voltage vectors having a phase difference of 60 degrees and at least a zero vector by allocating occurrence time ratios for two basic voltage vectors having a phase difference of  
10 60 degrees with a voltage command vector therebetween and a corresponding zero vector based on the voltage command vector; and

a distributing unit that distributes an occurrence time ratio of the voltage command vector to  
15 three basic voltage vectors having a phase difference of 120 degrees including one of the two basic voltage vectors having a phase difference of 60 degrees, using three vectors with equal lengths having a phase difference of 120 degrees and constituting a zero vector corresponding to the  
20 voltage command vector, to create,

when an operation request range on a low speed side is not stringent, a first combination of three basic voltage vectors having a phase difference of 60 degrees and at least a zero vector based on the occurrence time ratio  
25 distributed, and

when the operation request range on a low speed side is stringent, a second combination of three basic voltage vectors having a phase difference of 120 degrees and at least a zero vector based on the occurrence time  
30 ratio distributed, and

the three-phase PWM-signal generating apparatus further comprises a switching unit that switches, based on at least one of a load state, an operation frequency, and

an angle range of an inverter rotation angle of a motor driven by the three-phase voltage inverter, generation of a three-phase PWM signal using two kinds of basic voltage vectors having a phase difference of 60 degrees and at  
5 least one kind of a zero vector produced by the producing unit and generation of a three-phase PWM signal using, in a switching manner, three kinds of basic voltage vectors having phase differences of 60 degrees and one kind of a zero vector and three kinds of basic voltage vectors having  
10 phase differences of 120 degrees and at least one kind of a zero vector produced by the distributing unit.

10. An apparatus for generating a three-phase pulse-width-modulation signal for a three-phase voltage inverter  
15 employing a semiconductor switching element, the apparatus comprising:

a generating unit that generates the three-phase pulse-width-modulation signal based on a combination of three basic voltage vectors and two zero vectors.

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11. The apparatus according to claim 10, wherein the generating unit includes

a creating unit that creates two basic voltage vectors having a phase difference of 60 degrees and at  
25 least a zero vector by allocating occurrence time ratios for two basic voltage vectors having a phase difference of 60 degrees with a voltage command vector therebetween and a corresponding zero vector based on the voltage command vector; and

30 a distributing unit that distributes an occurrence time ratio of the voltage command vector to three basic voltage vectors having a phase difference of 120 degrees including one of the two basic voltage vectors



having a phase difference of 60 degrees, using three vectors with equal lengths having a phase difference of 120 degrees and constituting a zero vector corresponding to the voltage command vector, to create three basic voltage  
5 vectors having a phase difference of 60 degrees and two zero vectors based on the occurrence time ratio distributed.

12. The apparatus according to claim 10, wherein the generating unit includes

10 a creating unit that creates two basic voltage vectors having a phase difference of 60 degrees and at least a zero vector by allocating occurrence time ratios for two basic voltage vectors having a phase difference of 60 degrees with a voltage command vector therebetween and a  
15 corresponding zero vector based on the voltage command vector; and

a distributing unit that distributes an occurrence time ratio of the voltage command vector to three basic voltage vectors having a phase difference of  
20 120 degrees including one of the two basic voltage vectors having a phase difference of 60 degrees, using three vectors with equal lengths having a phase difference of 120 degrees and constituting a zero vector corresponding to the voltage command vector, to create three basic voltage  
25 vectors having a phase difference of 60 degrees and two zero vectors based on the occurrence time ratio distributed, while changing occurrence time ratios for the two zero vectors at a predetermined rate.

30 13. The apparatus according to claim 10, wherein the generating unit includes

a creating unit that creates two basic voltage vectors having a phase difference of 60 degrees and at

least a zero vector by allocating occurrence time ratios for two basic voltage vectors having a phase difference of 60 degrees with a voltage command vector therebetween and a corresponding zero vector based on the voltage command

5 vector; and

a distributing unit that distributes an occurrence time ratio of the voltage command vector to three basic voltage vectors having a phase difference of 120 degrees including one of the two basic voltage vectors  
10 having a phase difference of 60 degrees, using three vectors with equal lengths having a phase difference of 120 degrees and constituting a zero vector corresponding to the voltage command vector, to create three basic voltage vectors having a phase difference of 60 degrees and two  
15 zero vectors based on the occurrence time ratio distributed, with an occurrence time ratio of a basic voltage vector in a middle of the three basic voltage vectors having a phase difference of 60 degrees set to a predetermined value.

20 14. The apparatus according to claim 10, wherein the generating unit includes

a creating unit that creates two basic voltage vectors having a phase difference of 60 degrees and at least a zero vector by allocating occurrence time ratios  
25 for two basic voltage vectors having a phase difference of 60 degrees with a voltage command vector therebetween and a corresponding zero vector based on the voltage command vector; and

a distributing unit that distributes an  
30 occurrence time ratio of the voltage command vector to three basic voltage vectors having a phase difference of 120 degrees including one of the two basic voltage vectors having a phase difference of 60 degrees, using three

vectors with equal lengths having a phase difference of 120 degrees and constituting a zero vector corresponding to the voltage command vector, to create three basic voltage vectors having a phase difference of 60 degrees and two  
5 zero vectors based on the occurrence time ratio distributed, while changing occurrence time ratios for the two zero vectors at a predetermined rate with an occurrence time ratio of a basic voltage vector in a middle of the three basic voltage vectors having a phase difference of 60  
10 degrees set to a predetermined value.

15. The apparatus according to claim 10, wherein the generating unit includes
- a creating unit that creates two basic voltage  
15 vectors having a phase difference of 60 degrees and at least a zero vector by allocating occurrence time ratios for two basic voltage vectors having a phase difference of 60 degrees with a voltage command vector therebetween and a corresponding zero vector based on the voltage command  
20 vector; and
  - a distributing unit that distributes an occurrence time ratio of the voltage command vector to three basic voltage vectors having a phase difference of 120 degrees including one of the two basic voltage vectors  
25 having a phase difference of 60 degrees, using three vectors with equal lengths having a phase difference of 120 degrees and constituting a zero vector corresponding to the voltage command vector, to create three basic voltage vectors having a phase difference of 60 degrees and two  
30 zero vectors based on the occurrence time ratio distributed, and
- the three-phase PWM-signal generating apparatus further comprises a switching unit that switches, based on

at least one of a load state, an operation frequency, and an angle range of an inverter rotation angle of a motor driven by the three-phase voltage inverter, generation of a three-phase PWM signal using two kinds of basic voltage  
5 vectors having a phase difference of 60 degrees and at least one kind of a zero vector produced by the producing unit and generation of a three-phase PWM signal using three kinds of basic voltage vectors having phase differences of 120 degrees and two kinds of zero vectors produced by the  
10 distributing unit.

16. The apparatus according to claim 10, wherein the generating unit includes

a creating unit that creates two basic voltage  
15 vectors having a phase difference of 60 degrees and at least a zero vector by allocating occurrence time ratios for two basic voltage vectors having a phase difference of 60 degrees with a voltage command vector therebetween and a corresponding zero vector based on the voltage command  
20 vector; and

a distributing unit that distributes an occurrence time ratio of the voltage command vector to three basic voltage vectors having a phase difference of 120 degrees including one of the two basic voltage vectors  
25 having a phase difference of 60 degrees, using three vectors with equal lengths having a phase difference of 120 degrees and constituting a zero vector corresponding to the voltage command vector, to create three basic voltage vectors having a phase difference of 60 degrees and two  
30 zero vectors based on the occurrence time ratio distributed, while changing occurrence time ratios for the two zero vectors at a predetermined rate, and

the three-phase PWM-signal generating apparatus

further comprises a switching unit that switches, based on at least one of a load state, an operation frequency, and an angle range of an inverter rotation angle of a motor driven by the three-phase voltage inverter, generation of a three-phase PWM signal using two kinds of basic voltage vectors having a phase difference of 60 degrees and at least one kind of a zero vector produced by the producing unit and generation of a three-phase PWM signal using three kinds of basic voltage vectors having phase differences of 120 degrees and two kinds of zero vectors produced by the distributing unit.

17. The apparatus according to claim 10, wherein the generating unit includes

a creating unit that creates two basic voltage vectors having a phase difference of 60 degrees and at least a zero vector by allocating occurrence time ratios for two basic voltage vectors having a phase difference of 60 degrees with a voltage command vector therebetween and a corresponding zero vector based on the voltage command vector; and

a distributing unit that distributes an occurrence time ratio of the voltage command vector to three basic voltage vectors having a phase difference of 120 degrees including one of the two basic voltage vectors having a phase difference of 60 degrees, using three vectors with equal lengths having a phase difference of 120 degrees and constituting a zero vector corresponding to the voltage command vector, to create three basic voltage vectors having a phase difference of 60 degrees and two zero vectors based on the occurrence time ratio distributed, with an occurrence time ratio of a basic voltage vector in a middle of the three basic voltage vectors having a phase

difference of 60 degrees set to a predetermined value, and  
the three-phase PWM-signal generating apparatus  
further comprises a switching unit that switches, based on  
at least one of a load state, an operation frequency, and  
5 an angle range of an inverter rotation angle of a motor  
driven by the three-phase voltage inverter, generation of a  
three-phase PWM signal using two kinds of basic voltage  
vectors having a phase difference of 60 degrees and at  
least one kind of a zero vector produced by the producing  
10 unit and generation of a three-phase PWM signal using three  
kinds of basic voltage vectors having phase differences of  
120 degrees and two kinds of zero vectors produced by the  
distributing unit.

15 18. The apparatus according to claim 10, wherein  
the generating unit includes  
a creating unit that creates two basic voltage  
vectors having a phase difference of 60 degrees and at  
least a zero vector by allocating occurrence time ratios  
20 for two basic voltage vectors having a phase difference of  
60 degrees with a voltage command vector therebetween and a  
corresponding zero vector based on the voltage command  
vector; and  
a distributing unit that distributes an  
25 occurrence time ratio of the voltage command vector to  
three basic voltage vectors having a phase difference of  
120 degrees including one of the two basic voltage vectors  
having a phase difference of 60 degrees, using three  
vectors with equal lengths having a phase difference of 120  
30 degrees and constituting a zero vector corresponding to the  
voltage command vector, to create three basic voltage  
vectors having a phase difference of 60 degrees and two  
zero vectors based on the occurrence time ratio distributed,

while changing occurrence time ratios for the two zero vectors at a predetermined rate with an occurrence time ratio of a basic voltage vector in a middle of the three basic voltage vectors having a phase difference of 60 degrees set to a predetermined value, and

the three-phase PWM-signal generating apparatus further comprises a switching unit that switches, based on at least one of a load state, an operation frequency, and an angle range of an inverter rotation angle of a motor driven by the three-phase voltage inverter, generation of a three-phase PWM signal using two kinds of basic voltage vectors having a phase difference of 60 degrees and at least one kind of a zero vector produced by the producing unit and generation of a three-phase PWM signal using three kinds of basic voltage vectors having phase differences of 120 degrees and two kinds of zero vectors produced by the distributing unit.

19. An apparatus for generating a three-phase pulse-width-modulation signal for a three-phase voltage inverter employing a semiconductor switching element, the apparatus comprising:

a generating unit that generates the three-phase pulse-width-modulation signal based on a combination of three basic voltage vectors and a zero vector and a combination of three basic voltage vectors and two zero vectors.

20. The apparatus according to claim 19, wherein the generating unit includes

a creating unit that creates two basic voltage vectors having a phase difference of 60 degrees and at least a zero vector by allocating occurrence time ratios

for two basic voltage vectors having a phase difference of 60 degrees with a voltage command vector therebetween and a corresponding zero vector based on the voltage command vector; and

5                   a distributing unit that distributes an occurrence time ratio of the voltage command vector to three basic voltage vectors having a phase difference of 120 degrees including one of the two basic voltage vectors having a phase difference of 60 degrees, using three  
10                   vectors with equal lengths having a phase difference of 120 degrees and constituting a zero vector corresponding to the voltage command vector, to create a first combination of three basic voltage vectors having a phase difference of 60 degrees and a zero vector and a second combination of three  
15                   basic voltage vectors having a phase difference of 60 degrees and two zero vectors, in a switchable manner.

21. The apparatus according to claim 19, wherein the generating unit includes

20                   a creating unit that creates two basic voltage vectors having a phase difference of 60 degrees and at least a zero vector by allocating occurrence time ratios for two basic voltage vectors having a phase difference of 60 degrees with a voltage command vector therebetween and a  
25                   corresponding zero vector based on the voltage command vector; and

                  a distributing unit that distributes an occurrence time ratio of the voltage command vector to three basic voltage vectors having a phase difference of  
30                   120 degrees including one of the two basic voltage vectors having a phase difference of 60 degrees, using three vectors with equal lengths having a phase difference of 120 degrees and constituting a zero vector corresponding to the



voltage command vector, to create a first combination of three basic voltage vectors having a phase difference of 60 degrees and a zero vector and a second combination of three basic voltage vectors having a phase difference of 60

5 degrees and two zero vectors, in a switchable manner, while changing occurrence time ratios for the two zero vectors at a predetermined rate.

22. The apparatus according to claim 19, wherein

10 the generating unit includes

a creating unit that creates two basic voltage vectors having a phase difference of 60 degrees and at least a zero vector by allocating occurrence time ratios for two basic voltage vectors having a phase difference of

15 60 degrees with a voltage command vector therebetween and a corresponding zero vector based on the voltage command vector; and

a distributing unit that distributes an occurrence time ratio of the voltage command vector to three basic voltage vectors having a phase difference of 120 degrees including one of the two basic voltage vectors having a phase difference of 60 degrees, using three vectors with equal lengths having a phase difference of 120 degrees and constituting a zero vector corresponding to the

25 voltage command vector, to create a first combination of three basic voltage vectors having a phase difference of 60 degrees and a zero vector and a second combination of three basic voltage vectors having a phase difference of 60 degrees and two zero vectors, in a switchable manner, and

30 the three-phase PWM-signal generating apparatus further comprises a switching unit that switches, based on at least one of a load state, an operation frequency, and an angle range of an inverter rotation angle of a motor

driven by the three-phase voltage inverter, generation of a three-phase PWM signal using two kinds of basic voltage vectors having a phase difference of 60 degrees and at least one kind of a zero vector produced by the producing unit and generation of a three-phase PWM signal using, in a switching manner, three kinds of basic voltage vectors having phase differences of 60 degrees and one kind of a zero vector and three kinds of basic voltage vectors having phase differences of 60 degrees and two kinds of zero vectors produced by the distributing unit.

23. The apparatus according to claim 19, wherein the generating unit includes

a creating unit that creates two basic voltage vectors having a phase difference of 60 degrees and at least a zero vector by allocating occurrence time ratios for two basic voltage vectors having a phase difference of 60 degrees with a voltage command vector therebetween and a corresponding zero vector based on the voltage command vector; and

a distributing unit that distributes an occurrence time ratio of the voltage command vector to three basic voltage vectors having a phase difference of 120 degrees including one of the two basic voltage vectors having a phase difference of 60 degrees, using three vectors with equal lengths having a phase difference of 120 degrees and constituting a zero vector corresponding to the voltage command vector, to create a first combination of three basic voltage vectors having a phase difference of 60 degrees and a zero vector and a second combination of three basic voltage vectors having a phase difference of 60 degrees and two zero vectors, in a switchable manner, while changing occurrence time ratios for the two zero vectors at

a predetermined rate, and

the three-phase PWM-signal generating apparatus further comprises a switching unit that switches generation of a three-phase PWM signal using two kinds of basic  
5 voltage vectors having a phase difference of 60 degrees and at least one kind of a zero vector produced by the producing unit and generation of a three-phase PWM signal using three kinds of basic voltage vectors having phase differences of 60 degrees and one kind of a zero vector and  
10 three kinds of basic voltage vectors having phase differences of 60 degrees and two kinds of zero vectors produced by the distributing unit.